An Estimate of Carbon Sequestration through Afforestation in the Lower Mississippi Alluvial River Valley

Theodor D. Leininger[1], Emile S. Gardiner[1], Lisa Samuelson[2] and John A. Stanturf[3]

[1]USDA Forest Service, Southern Research Station, Center for Bottomland Hardwoods Research, Stoneville, MS, E-mail: tleininger@fs.fed.us; [2]School of Forestry and Wildlife Sciences, Auburn University, Auburn, AL; [3]USDA Forest Service, Southern Research Station, Athens, GA, USA

Bottomland hardwood forests once occupied about 10 million hectares of the Lower Mississippi River Alluvial Valley (LMRAV). More than one hundred and fifty years of land clearing for agriculture have reduced bottomland hardwood forests in the LMRAV to about two million hectares. Changing market forces and land use policies are prompting current landowners to afforest agricultural lands, especially those that are unproductive. To date, more than 200,000 hectares have been afforested. Energy producers are paying to afforest cleared lands for the purpose of carbon sequestration with the goal of earning carbon credits. However, few studies have been done to determine the amounts of carbon that can be sequestered over time by various bottomland hardwood species.

Increases in atmospheric CO_2 concentrations due to human activities could potentially affect the global climate. The scientific community's inability to balance the present global CO_2 budget illustrates a lack of understanding of the global carbon cycle. Before human influences, transfers were approximately equalized so that the amount of CO_2 in the atmosphere had remained nearly constant for thousands of years. The increase in atmospheric CO_2 over the last 100 years is primarily a result of the burning of fossil fuels. However, CO_2 concentration in the atmosphere is also influenced by human modifications of the land surface by harvesting forest products, farming, and urban development, which significantly alter the cycle of carbon accumulation and distribution on the land surface. The amount of human induced CO_2 appears to exceed the amount accumulating in the atmosphere and oceans.

Deforestation, land cover change, and combustion of fossil fuels are estimated to produce a combined total of about 8.0 billion metric tons of carbon per year. About 5.0 billion metric tons per year of this carbon is believed to be absorbed by the atmosphere and the oceans, leaving a balance of 2 to 3 billion metric tons of carbon per year needed to balance the CO_2 budget. Mounting evidence points toward this carbon being absorbed in the temperate latitudes of North America, Europe, and Asia, probably by land

plants and eventually incorporated in soils or sediments. While there is uncertainty about flux estimates for deforestation and land cover change, carbon absorbed by oceans, and carbon absorbed by terrestrial sinks, afforestation in the Lower Mississippi River Alluvial Valley falls into the arena of Northern Hemispheric forest growth as a part of the larger terrestrial carbon sink. It is therefore appropriate to ask, "just how much carbon might possibly be sequestered by new forests gained through afforestation efforts in the LMRAV?"

There are at least four sets of factors to consider in thinking about the potential for carbon sequestration resulting from afforestation in the LMRAV. The first set of factors is that of logistics, or quite simply who is going to plant the trees, and where and how fast will they plant them? A second consideration is that of tree biology. Which tree species will be planted, at what density, and on which sites? A third set of factors involves social and economic questions. Are people motivated to plant trees purely for money, or is it because of environmental concerns, or some combination of the two? Simply put, what are the costs and what are the benefits of afforestation? The fourth consideration is that of the politics behind the carbon credit issue, as well as the government programs and agencies that foster afforestation, and the laws that motivate landowners, private or corporate, to make decisions about land use. Numerous federal and state government agencies, agency partnerships, non-governmental groups, energy companies, and private landowners are planting bottomland hardwoods on agricultural land throughout the LMRAV at an average estimated yearly rate of 10,000 to 12,000 hectares. A university study of an Eastern cottonwood (*Populus deltoides*) monoculture forest estimated CO_2 accumulation per hectare over seventy years. Estimates ranged from 0.7 metric tons of CO_2 per hectare per year for a one-year-old stand to 220 metric tons of CO_2 per hectare per year for a seventy-year-old stand. Assuming a planting rate of 11,571 hectares per year, it would be feasible to afforest 810,000 hectares, or roughly ten percent of the non-forested area of the LMRAV, in seventy years. One organization has set an ambitious goal of afforesting 810,000 hectares in twenty years; in this example, we allow seventy years for that to happen. Thus in this example, at year seventy there would be 11,571 hectares of one-year-old forest fixing about 7,600 metric tons of CO_2, 11,571 hectares of two-year-old forest fixing 15,700 metric tons of CO_2, and so on, to 11,571 hectares of seventy-year-old trees fixing 2.5 million metric tons of CO_2. The total of all afforested hectares at seventy years yielded about 25×10^6 metric tons of carbon fixed under this scenario. Dividing the mass of carbon fixed in the 810,000 hectares of afforestation in the LMRAV by seventy years of steady-state carbon released into the atmosphere at the annual rate of 3 billion metric tons of carbon, which possibly is being sequestered in terrestrial sinks, yields a 0.01 percent rate of carbon sequestration. Comparing this estimate of carbon captured in the LMRAV to amounts of carbon produced by various sectors of the United States economy will provide an estimate of the economic value of afforestation in the region.